

CLAIMS

I/we claim:

1. A mercury-free arc tube for a discharge lamp unit comprising:

5 a spheroidal closed glass bulb;
a pinch seal on each end of the closed glass bulb; and
opposing electrodes disposed in the glass bulb, the glass
bulb being filled with a primary light-emitting metal-halide
and a starting rare gas, a pressure of the starting rare gas
10 being 8 to 20 atm, wherein an inner diameter of the glass bulb
at a middle part between the opposing electrodes is 1.5 to 2.7 mm,
a distance between the opposing electrodes is 1.0 to 4.0 mm,
a length of each of the electrodes extending into the glass bulb
is 0.3 to 1.8 mm, and a stable discharge is produced with a power
15 of 15 to 30 W.

2. A mercury-free arc tube according to claim 1, further
comprising a buffer metal halide, wherein the primary
light-emitting metal halide is at least one member selected from
an Na halide, an Sc halide, and a Dy halide, the buffer metal
20 halide is at least one member selected from an Al halide, a Cs
halide, an Ho halide, an In halide, a Tl halide, a Tm halide,
and a Zn halide, the total amount of the metal halides in the
glass bulb is 10 to 30 mg/ml, and the ratio of the buffer metal
halide to the total amount of the metal halides is 0 to 50% by
25 weight.

3. A mercury-free arc tube according to claim 1, wherein a ratio of an inner diameter D2 of the glass bulb at tips of the opposing electrodes to an inner diameter D1 of the glass bulb at the middle part between the opposing electrodes ($D2/D1$) is 0.5 to 1.0.
4. A mercury-free arc tube according to claim 1, wherein a ratio of a tube current I (unit: A) supplied to the arc tube to the outer diameter d (unit: mm) of the electrodes sticking out inside the glass bulb (I/d) is 1.0 to 4.0 (A/mm).
5. A mercury-free arc tube according to claim 1, further comprising a cylindrical glass shroud integrally welded to said arc tube to provide a closed space enclosing the glass bulb, the closed space being filled with an inert gas at a pressure of 1 atm or lower.
6. A mercury-free arc tube for a discharge lamp unit, comprising:
a closed glass bulb having a first end closed at a first pinch seal and a second end closed at a second pinch seal; and
a first electrode extending into said closed glass bulb from said first end, and a second electrode extending into said closed glass bulb from said second end, wherein said closed glass bulb contains a mixture comprising a primary light-emitting halide and a starting rare gas, and wherein a total amount of metal halides in said mixture is between 10 and 30 mg/ml, and about 15 W to 30 W is required to power said arc tube.

7. The arc tube of claim 6, further comprising:
a lighting circuit, coupled to said first electrode and
said second electrode, for lighting said arc tube,
including,

5 a switching regulator coupled between a battery and
said arc tube, for converting a battery voltage from said
battery into a tube voltage;

a control circuit coupled between said switching
regulator and said arc tube, for detecting said tube
10 voltage and a tube current of said arc tube as a feedback
signal, and controlling said tube voltage output by said
switching regulator in response to said feedback signal;

a starter circuit that receives said tube voltage
controlled by said regulator, and outputs said tube voltage
15 to a first electrode of said arc tube; and

a DC/AC converter coupled between said control
circuit and said starter circuit, that converts said tube
voltage output from said switching regulator from a DC
voltage into an AC voltage.

20 8. The arc tube of claim 6, wherein said mixture further
comprises a buffer metal halide that includes at least
one of an Al halide, a Cs halide, an Ho halide, an In halide,
a Tl halide, a Tm halide and a Zn halide, and a ratio of
said buffer metal halide to a total amount of metal halides
25 is between 0 and 50 percent, and further wherein said

primary light-emitting halide comprises at least one of a Na halide, a Sc halide and a Dy halide.

9. The arc tube of claim 6, wherein said first electrode is coupled to a metal lead support, and said second end is coupled to an insulating plug body of a vehicular lamp, and said discharge lamp unit is used in a vehicle lighting system.

10. The arc tube of claim 6, further comprising a shroud integrally welded to said arc tube, wherein said shroud shields ultraviolet light in a wavelength range and maintains an operational temperature of said arc tube, said shroud is made of quartz glass doped with at least one of TiO_2 and CeO_2 , said wavelength range comprises ultraviolet rays harmful to the human body, and a closed space defined by said closed glass bulb and said glass shroud is charged with an inert gas at a pressure of about 1 atm or less.

11. The arc tube of claim 6, wherein a diameter at a middle portion of said glass bulb is between about 1.5 mm and 2.7 mm.

12. The arc tube of claim 6, wherein a distance between said first electrode and said second electrode that extend into said glass tube is between about 1.0 mm and 4.0 mm.

13. The arc tube of claim 6, wherein a length of a portion of said first electrode and said second electrode that

extends into said glass tube is about 0.3 mm to 1.8 mm.

14. The arc tube of claim 6, wherein said starting rare gas is xenon, said first and second electrodes are tungsten electrodes, and said starting rare gas has a pressure
5 between about 8 atm and 20 atm.

15. The arc tube of claim 6, further comprising molybdenum foils pinch-sealed into said first and second pinch seals, and connected to outer ends of said first and second electrodes, respectively, wherein said closed glass bulb
10 is spheroidal and said pinch seals are substantially rectangular.

16. The arc tube of claim 6, wherein a ratio of an inner diameter (D2) of said closed glass bulb at inner tips of said first and second electrodes extending into said closed glass bulb, to an inner diameter (D1) of said closed glass bulb
15 at a middle portion of said closed glass bulb, is between about 0.7 and 0.9.

17. The arc tube of claim 6, wherein a ratio of a received tube current (I) to an outer diameter (d) of said first electrode and said second electrode is between about 2.0
20 and 3.5.

18. A lighting circuit for supplying electricity to an arc tube for a discharge lamp unit that includes a closed glass bulb having a first electrode extending into said closed
25 glass bulb from a first end and a second electrode extending

into said closed glass bulb from a second end, said lighting circuit comprising:

5 a switching regulator coupled between a battery and said arc tube, for converting a battery voltage from said battery into a tube voltage;

a control circuit coupled between said switching regulator and said arc tube, for detecting said tube voltage and a tube current of said arc tube as a feedback signal, and controlling said tube voltage output by said
10 switching regulator in response to said feedback signal; and

a starter circuit that receives said tube voltage controlled by said regulator, and outputs said tube voltage to a first electrode of said arc tube, wherein said lighting
15 circuit is coupled to said first electrode and said second electrode, and about 15W to 30W is provided to said arc tube.

19. The circuit of claim 18, further comprising a DC/AC converter coupled between said control circuit and said
20 starter circuit, that converts said tube voltage output from said switching regulator from a DC voltage into an AC voltage.

20. The circuit of claim 18, wherein said tube voltage output is received by said starter circuit as a DC voltage.